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Docket No.: INF-P80224 US

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By: _____ Date: June 22, 2004

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applic. No.	:	09/734,467 Confirmation No.: 5119
Inventor	:	Gerhard Beitel et al.
Filed	:	December 11, 2000
Title	:	Methods for Producing a Structured Metal Layer
TC/A.U.	:	2822
Examiner	:	Kevin M. Picardat
Customer No.	**:**	**24131**

Hon. Commissioner for Patents
Alexandria, VA 22313-1450

R E P L Y B R I E F

S i r :

Responsive to the *Examiner's Answer* dated April 22, 2004, the following supplemental arguments are submitted. Appellants respectfully request that the following arguments be incorporated into the record of the appeal.

In the Examiner's Answer, the Examiner stated that claims 1-3, 7, 11-13, 15, and 17 are unpatentable over Kawakubo in view of Azuma. It is further stated in the Examiner's Answer that claims 19-21 and 23 are also unpatentable over

Kawakubo in view of Azuma and further in view of Russel, and claims 19, 20, and 22 are unpatentable over Kawakubo in view of Azuma and further in view of Kirlin.

Appellants agree with the Examiner that Kawakubo *"do not teach that the bottom electrode is formed by applying a precious metal and a donor material and subjecting the layers to a heat treatment"*. Therefore, claim 1 is distinguishable over Kawakubo.

However, appellants disagree with the Examiner's statement that it is obvious for a person skilled in the art to add a heat treatment to the process of Kawakubo.

The present invention solves the problem that by *"subjecting the layers to heat treatment ... such that the additive diffuses into the precious metal and an alloy layer is produced"* (claim 1), it is possible to structure precious layers without scratches, which otherwise *"can render a chip unusable"* (see page 5, line 16 of the instant specification). The claimed invention uses the effect that the thus produced alloy layer is easier to mechanically and chemically structure with conventional slurries than the precious layer alone (for further explanation see page 7, lines 9-19 of the instant specification).

Appellants submit that one skilled in the art starting with Kawakubo would not arrive at implementing the step of *"subjecting the layers to heat treatment ... such that the additive diffuses into the precious metal and an alloy layer is produced" as recited in* claim 1 for the following reasons:

Kawakubo does not solve the same problem as the present invention, i.e. Kawakubo is not concerned with scratching the surface of the precious layer 13 during mechanically and chemically structuring (see Fig. 4D). The reason is that precious layer 13, in the relevant region below polishing stop region 10, is covered by BSG-layer 16 which protects precious layer 13 from scratches during structuring. Further, in the other region where precious layer 13 is not protected by BSG-layer 16, scratches of precious layer 13 due to mechanical and chemical structuring are without any consequences since in this region, precious layer 13 becomes removed anyway.

Therefore, one skilled in the art would not be motivated to modify the structuring process in Kawakubo, because in Kawakubo scratching the bottom electrode does not cause any harm. In particular, one skilled in the art would not modify the process of Kawakubo by including a heating step because, without obtaining any positive advantage or benefit, he would

have to deal with the well-known undesirable side-effects caused by heating, e.g. diffusion of the *"barrier metal film* 12 *made of titanium nitride"* (column 7, lines 48-49) which is *"particularly problematic* in *integrated circuits because the titanium cations typically present a variety of valence states... which induce corresponding lattice defects..."* (see column 1, lines 37-44 of Azuma).

Therefore, because there is no incentive and in view of the potential problems, a skilled person would avoid including a heat treatment in Kawakubo's process.

The Examiner appears *to* argue (see page 5, 1st paragraph of the Examiner's Answer) that the problem of a metal flow that "will *result* in *the problem that the bottom electrode and the top electrode of the charge storage electrode and the top electrode of the charges storage element are short-circuited to each other"* (column 6, lines 4-7 *of* Kawakubo) would motivate a person skilled in the art to combine the heating step *of* Azuma with the disclosure of Kawakubo.

Appellants disagree with the Examiner's assessment and reasoning, since the heating step in Azuma is directed to solve a different problem than that disclosed in Kawakubo as discussed above.

Azuma is attempting to solve the problem *of "shortening that is induced* by *the cracking or peeling of one thin film layer away from another layer* due to poor bonding *between the adjacent layer"* (see column 1, lines 27-31). Accordingly, there *"remains a need for effective bottom electrode structure that adheres well.."* (column 1, line 54). The problem is solved by providing a barrier layer *"formed of* an *adhesion metal portion and a noble metal portion that are at least partially interdiffused with* one *another, e.g.* by *simultaneously annealing the respective portions to at least partially combine them"* (column 2, lines 21-24).

In contrast thereto, Kawakubo is attempting to solve *"the problem that the bottom electrode and the top electrode of the charge storage electrode and the top electrode of the charge storage element are short-circuited to each other"* (see column 6, lines 4-7 of Kawakubo) due to *prominent metal flow"* during chemical-mechanical polishing (column 5, line 66 to column 6, line 4). The metal flow is prevented *"by using a conductive layer made of noble metal alloy which has been prepared by adding an appropriate amount of an additive to noble metal and which has a sufficient electrical conductivity and a proper hardness"* (column 6, lines 9-14). Examples of possible alloys are described in column 6, lines 30-33 of Kawakubo.

Therefore, Kawakubo provides a solution to the problem of "short-circuited bottom and top electrodes." Therefore, a person skilled in the art would not look for another solution to the problem, and would not combine the heating step of Azuma with the Kawakubo disclosure.

Further, even if one skilled in the art would consider Azuma's disclosure on how to reduce the short-circuits between top and bottom electrode of Kawakubo, he would find that Azuma is only concerned with better adherence of a precious layer with an adjacent layer. This teaching would not motivate a person skilled in the art to modify the method of Kawakubo to have a heat treatment as claimed. In particular, this would not motivate a person skilled in the art to combine the heating step of Azuma with the method of Kawakubo, particularly in view of the problems that additional heating steps cause to semiconductor structures.

Therefore, since there is no motivation for combining the heating step of Azuma with the method of Kawakubo, appellants submit that claim 1 is not obvious over Kawakubao in view of Azuma.

Appellants also point out that improving adherence of the

precious layer 13 to its adjacent layer is not a motivation for a person skilled in the art to combine Azuma with Kawakubo. This is because in Kawakubo good adherence is already provided by *"barrier metal film* 12 *made of titanium nitride"* (column 7, line 48-49 in Kawakubo) which can also be *"made of titanium, tantalum, tantalum nitride or the like"* (column 7, lines 48-49 in Kawakubo). Those materials are known to provide good adherence (see e.g. Azuma, column 1, lines 33-36).

Therefore, one skilled in the art trying to improve the CMP-structuring method of Kawakubo would not have any reason to rely on or refer to Azuma.

And even if one skilled in the art relied on Azuma, he would be taught by Azuma to avoid using the teachings of Azuma since he would find therein that the *"application of titanium metal proved to be problematic"* since *"the additional titanium served to contaminate other layers through titanium diffusion"* which is *"particularly problematic in integrated circuits because the titanium cations typically present a variety of valence states... which induce corresponding lattice defects..."* (column 1, lines 37-44 of Azuma). In addition, since the teaching of Azuma includes that the substrate is

"heated in a diffusion furnace under an oxygen atmosphere to a temperature ranging from 450° to 1000° (column 8, lines 37-40), a person skilled in the art would be discouraged from applying the teaching of Azuma to the method of Kawakubo since he would have known that the heating potentially causes even more contamination.

It appears that the Examiner's arguments are based on the assumption that the problem of *"short-circuited"* bottom and top electrodes mentioned in Kawakubo in column 6, lines 5-6, is the same as the problem of *"short-inducing surface regularities"* mentioned and addressed in Azuma. However, appellants submit that this is incorrect.

As discussed above, the problem of *"short-circuited"* bottom and top electrodes disclosed in Kawakubo relates to short-circuits that are generated between two layers by metal flow during chemical-mechanical polishing (column 5, lines 66 to column 6, line 7). The problem is solved by providing *"an alloy which has a sufficient hardness"* (column 6, lines 26-27).

Contrary to this, the problem of *"short-inducing surface*

irregularities" disclosed in Azuma, relates to irregularities of a layer due to poor bonding to an adjacent layer (column 1, lines 27-30). This problem is solved by <u>better adherence</u> of the layer to the adjacent layer. Note in particular that, unlike the *"short-circuited"* bottom and top electrodes in Kawakubo, the *"short-inducing surface irregularities"* of Azuma are generated <u>without</u> external polishing forces, and <u>before</u> a top electrode is applied.

Therefore, despite the similar wordings of *"short-circuited"* of Kawakubo and *"short-inducing"* of Azuma, the two problems are completely different. Azuma does not disclose anything about the problem of *"short-circuited"* bottom and top electrode of Kawakubo and therefore, the references cannot be properly combined.

Contrary to the statement in the Examiner's Answer on page 9, second paragraph, the problem of short-circuited bottom and top electrodes of Kawakubo would not have motivated a person skilled in the art to combine the teaching of Azuma with Kawakubo.

Appellants also would like to correct a potentially misleading statement on page 4, last paragraph of the Examiner's Answer,

wherein it is stated that in Azuma, *"the thickness of the donor material is selected such that during heat treatment the donor material essentially diffuses completely into the precious metal."* Almost the opposite is true. In column 5, lines 8-26 of Azuma, it is stated that line 42 (which in Fig. 1 represents the lower edge of barrier region 38) *"may be positioned anywhere within the adhesion metal layer* 34", (lines 11-12) and further that *"in most circumstances, barrier region* 38 *extends only partially, if at all, into adhesion metal layer* 34" (lines 23-26). This implies that, in general, the thickness of the donor material is selected such that the donor material does not diffuse completely into the precious metal.

The Examiner's statement may be misleading since it seems to be used as an argument that combining Azuma with Kawakubo would provide Kawakubo with an additional advantage that would motivate a person skilled in the art to apply the teaching of Azuma to Kawakubo. However, Azuma does not mention any additional advantage other than that its method improves the adherence of the layer to the underlying layer.

Further, the fact that the donor layer generally is not completely diffused into the precious layer underlines the

function of the donor material as being a layer between the precious layer 13 and an underlying layer for adhering the precious layer to the underlying layers, instead of hardening the precious layer.

In summary, appellants submit that it is not obvious to combine Azuma with Kawakubo so that Kawakubo would have the step of *"subjecting the layers to heat treatment ... such that the additive diffuses into the precious metal and an alloy layer is produced" as recited in* claim 1, and that the only basis for such a combination is impermissible hindsight as discussed in appellants' Brief.

Appellants respectfully request that the instant response to the issues raised by the Examiner be included in the record of the instant appeal.

Respectfully submitted,

LAURENCE A. GREENBERG
REG. NO. 29,308

For Appellants

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Lerner and Greenberg, P.A.
Post Office Box 2480
Hollywood, FL 33022-2480
Tel: (954) 925-1100
Fax: (954) 925-1101
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